Princeton University

October 10, 2001

- **Full-Envelope Flight Control Using an Adaptive Critic Neural Neural Network, Silvia Ferrari**
- **Optimal Nonlinear Neural Network Controllers for Aircraft, Aircraft, Nilesh Kulkarni**
- **Coordinated Flight of Uninhabited Air Vehicles, Olivier Laplace**
- **Air Transportation After September 11th, Robert Stengel**

Joint University Program for Air Transportation Research

Air Transportation After September 11th, Robert Stengel

Terrorist Mass Murder: New 'Weapon of Choice'.

Grotesque transformation of airliners into weapons of mass destruction destruction stirs profound reassessment of U.S. strategy and national security

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A Critical Assault on Liberty, Justice, Peace, and Freedom of the Skies

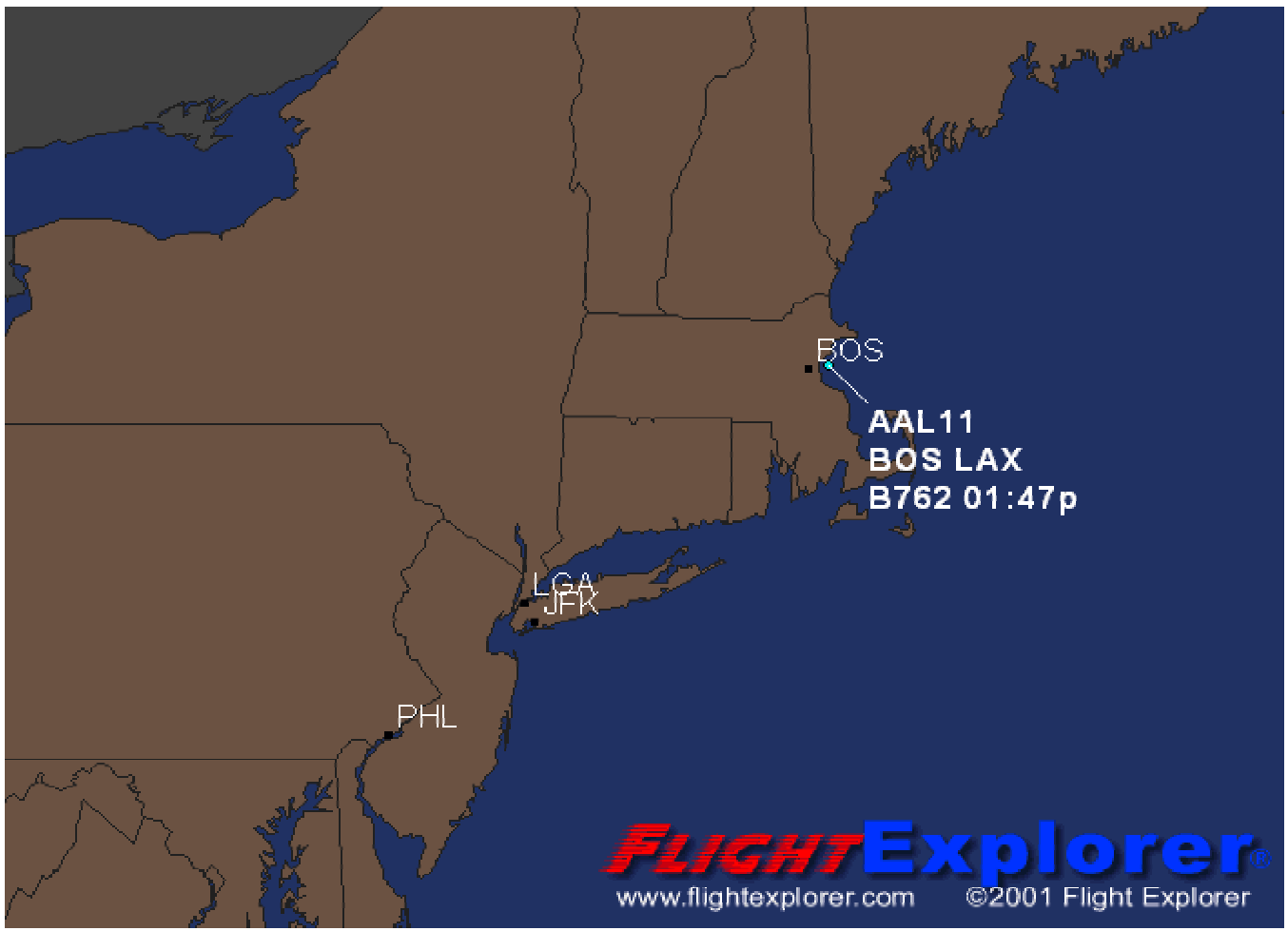
Sixteen of the 19 bombers bombers were here on legal visas

Three Are Held in Detroit After Airport Diagram Is Found

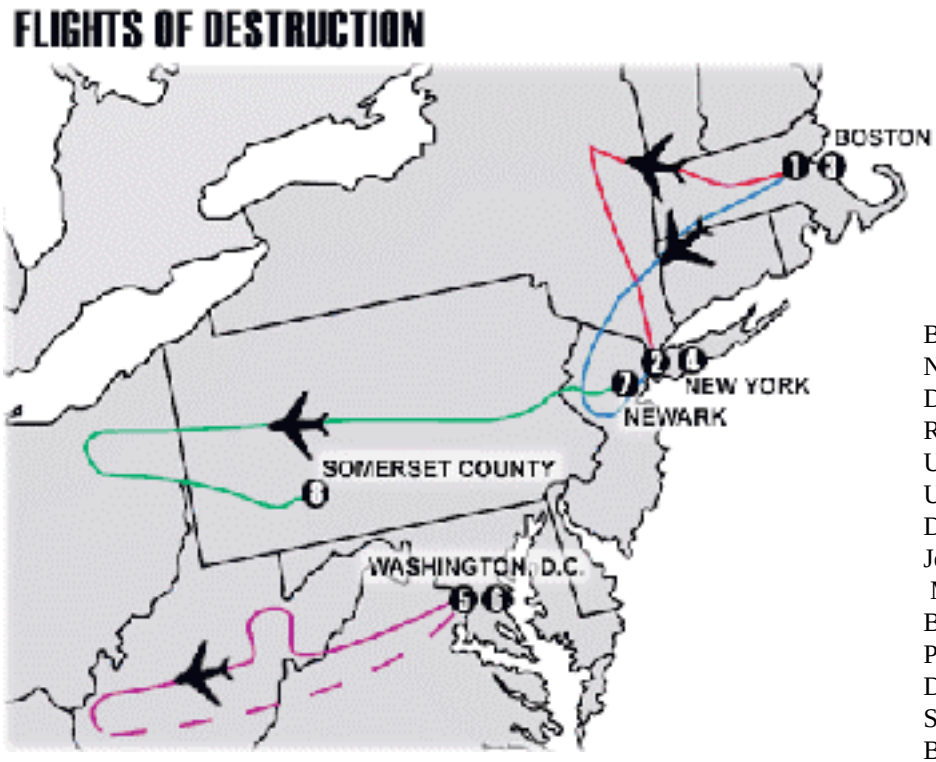
Pilot Held in London Was Hijacking Suspects' Lead Trainer, Trainer, Prosecutor Says

- **The notion of a fair and peaceful Global Village depends on the good will of all all of its citizens**
- **The terrorists took advantage advantage of our open society society to cause it great harm harm**
- **The instruments of terror were almost entirely of American origin**
- **Efforts to preserve justice and and peace may restrict liberty liberty and freedom**
- **DoT Rapid Response Team reports:**
  http://www.dot.gov/affairs/airportsec.htm
  http://www.dot.gov/affairs/aircraftsec.htm

American Airlines Flight 11 and United Airlines Flight 175, September 11, 2001



Was the Global Positioning System (GPS) an Enabling Technology for the Attacks?



Battery Life	8-24 hr
Number of User Waypoints	500
Display Size	2.2 x 1.5
Receiver**	12 channel
Unit Size	2.32 x 5 x 1.62
Unit Weight	9 oz
Database Options	Americas, Pacific Intl, Atlantic Intl.
Jeppesen Database***	Full, plus ARTCC and FSS frequencies
Moving Map	YES
Basemap	20 MI
Pixels	100 x 160
Display Type	High-Contrast FTN 4 level gray
Standard Accessories	Dash mnt, batteries
Built-in H.S.I.	YES
IFR or VFR	VFR
MSRP****	$549 (street: $475)

What is the Outlook for Commercial Airlines?

Bleak Financial Outlook Suddenly Appears Bleaker

- Schedule reductions of ~20%
- Airline load factors average less than than 50%; downsizing of aircraft in each market likely
- 7,000 commercial aircraft; airlines may park up to 900: B-727s, DC-10s, 10s, B-737s, MD-11s, DC-9s, MD-80s 80s
- Airlines are likely to suffer their largest ever losses over the next few months; layoffs of 90,000, fare sales
- Air Transportation Safety and Stabilization Act: $5B cash, $10B loan guarantees, *de facto* regulation
- High carrying costs, low margins, need for high cash flow
- Consolidation and bankruptcy; survival of the fittest

What is the Likely Market for Advanced Jet Transports?

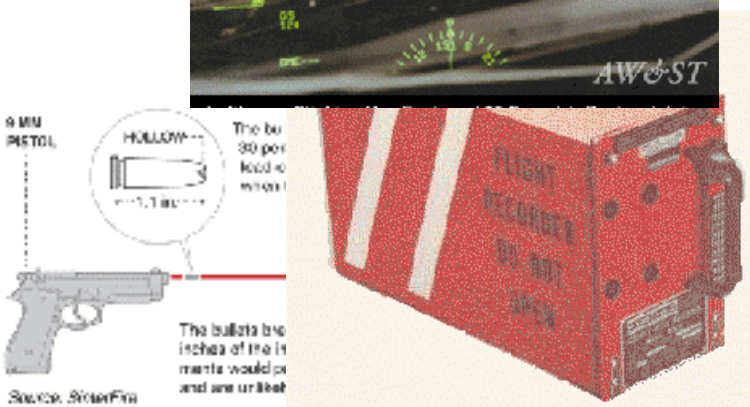
- **Boeing cuts delivery estimates by by 100 aircraft in next 15 months, prepares for layoffs of up to 30,000 people, proceeds with Sonic Cruiser; backlog of 980 aircraft (through 2002); diversification strategy projects smaller percentage of earnings from commercial aircraft**
- **With engine manufacturers and suppliers, 100,000 layoffs likely**
- **Airbus does not cut back, proceeds with A380, forecasts 15% earnings growth; backlog of of 1,714 aircraft**

Air Traffic Control and the National Airspace System

The FAA reopened the National Airspace System (NAS) to commercial and private aviation Sept. 13 at 11 a.m. EDT

- **Reprieve for NAS growth rate? rate?**
- **Air Traffic Control alerts**
- **Enhanced telemetry (e.g., IFF, Mode S)**
- **Allowable flight paths and "no- "no-fly" zones; is Reagan National Airport a problem?**
- **Reliance on GPS**
  - **WAAS, LAAS**
  - **Selective Availability, level of signal signal degradation**
  - **Deprivation of service in national emergency (e.g., jamming, outage)**
- **GLONASS/GNSS**
- **New life for conventional navaids**

Aircraft Systems, Flight Deck Procedures, and the Department of Dirty Tricks

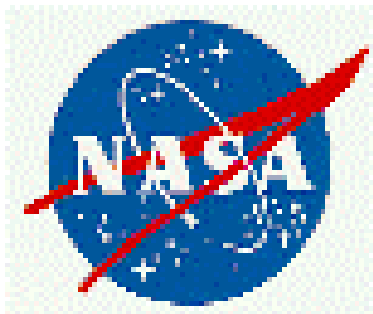


- In-flight alternatives should be be the last line of defense
- CVRs, DFDRs, circuit breakers breakers
- Tight ACARS loop to every commercial aircraft
- Defensive maneuvers, cabin pressurization, armed crew, crew ID interlocks on controls
- New equipment and retrofit to old aircraft: reliability, expense, probability of need
- Anti-terrorist autopilots?
- Methods of degrading aircraft guidance, navigation, and control can be considered

General Aviation: Part of the Solution or Part of the Problem?

- Business aircraft, fractional shares, charter flights
- FBOs, flying schools, traffic reporters, banner tows, crop crop dusters
- Private aircraft/amateur pilots
- Security at 4,500 public use airports; mingling at larger airports
- IFR vs. VFR
- “Keep-out” radii around major airports and facilities
- Background checks required required for pilot training and license

Research Areas for the FAA and NASA



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- **FAA**
  - **Prevention of incidents at or before the gate**
  - **Enhanced communications of aircraft intent**
  - **Quick ATC response to terrorist incidents**
  - **Navigation system alternatives to unfettered GPS**
- **NASA**
  - **Aircraft design and operational issues**
  - **Degraded/directed performance alterations to aircraft GNC**
  - **Human factors of crew response to terrorist attack**
  - **Development of crew training regimen**